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HARTCROWSER

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MEMORANDUM

MATTHEW WILLIAM VEENSTRA
STATE OF WASHINGTON
45280
REGISTERED
PROFESSIONAL ENGINEER

3/12/2021

DATE: March 12, 2021

TO: Mark Presleigh, Lease Crutcher Lewis

FROM: David Winter, PE and Matt Veenstra, PE

RE: **The Net**
Geotechnical Recommendations for Rubble Berm Support of Basement Walls
19567-01

This memorandum provides geotechnical recommendations for design and construction of temporary rubble berms (berms) to support existing basement walls during and after demolition of the existing building and basement interior structure.

We understand the demolition is scheduled to start in February 2021. Demolition will leave existing basement walls in place with concrete rubble placed against the basement walls to provide temporary support until the start of shoring for the future building excavation. The berms will support the existing basement walls along Third Avenue, Marion Street, Columbia Street, and the southern half of the alley on the south side of the site (Exhibit 2). Once shoring for the building begins the rubble berms will provide a working pad for construction equipment including equipment for installation of soldier piles and for tiebacks.

3131 Elliott Avenue, Suite 600
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206.324.9530

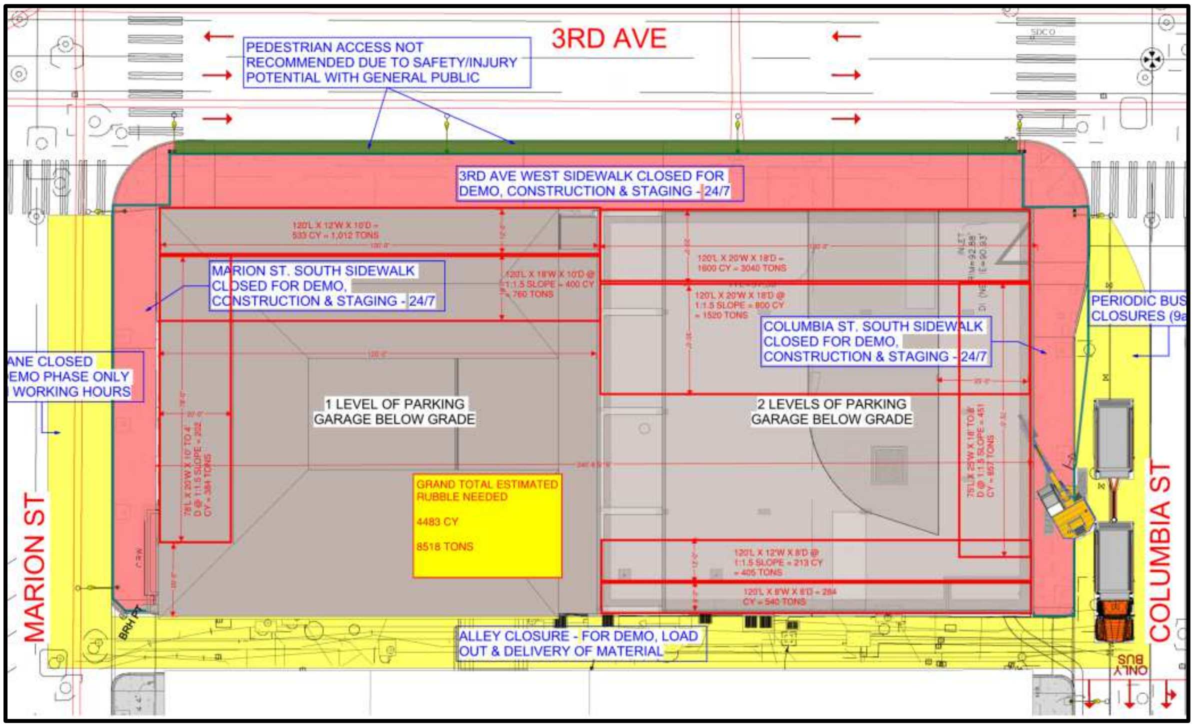

Exhibit 1 – Preliminary Rubble Berm Layout – Actual Layout Not Yet Determined

Crushed Concrete Rubble Berm Material

Based on correspondence with Lease Crutcher Lewis and RHINE we understand the concrete will be processed to approximately 12-inches-minus average size by excavator mounted hydraulic breakers and pulverizing attachments. The concrete rubble will not be further crushed or screened.

Construction of Rubble Berms

We understand that concrete slabs will be removed across most of the basement level except as needed to support and/or protect existing wall footings. Therefore, the berms may be placed on a combination of existing concrete slab and soil.

We assume that the rubble will be placed in nominal 18-inch-thick lifts and uniformly tamped or tracked into place using an excavator bucket (or similar).

RHINE plans to maintain the existing drainage during and after demolition so that surface water cannot pool within the excavation.

Berm Geometry

We assume a berm geometry like that shown in Exhibit 2. The fill slope is assumed to be no steeper than 1.5H:1V.

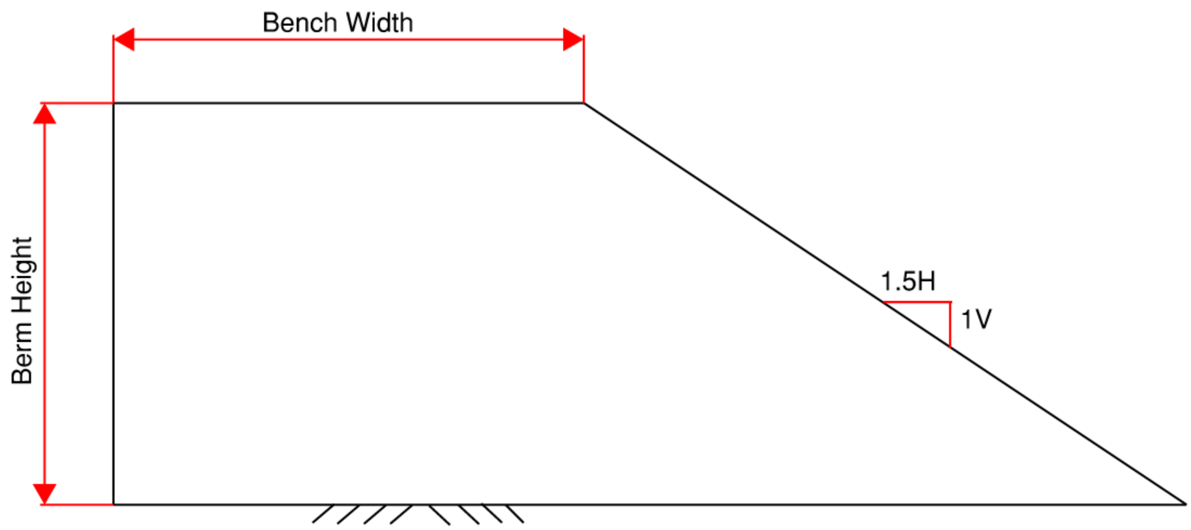

Exhibit 2 – Berm Geometry

Lateral Sliding Resistance

Lateral sliding of the existing walls is resisted by sliding friction beneath the existing wall foundation combined with the lateral resistance of the rubble berm. The total lateral resistance of the rubble berm is the **lesser of** the passive soil resistance of the berm or the base friction sliding resistance of the berm.

Base Sliding Friction of Existing Wall Foundation

For base sliding friction of the existing wall foundations, we recommend calculating the ultimate base friction sliding using an interface friction angle of 22 degrees (friction coefficient of 0.4). To calculate the sliding friction, the structural engineer will need to determine the normal reaction force against the bottom of the footing for the actual conditions at the time of demolition activities.

We recommend applying a factor of safety of 1.3 to calculate the allowable base friction sliding capacity of the existing wall foundation.

Base Friction Sliding of Rubble Berm

The lateral resistance of the rubble berm is the lesser of the allowable passive earth pressure and the allowable base friction sliding capacity of the berm.

For base sliding friction of the berm we recommend calculating the ultimate base friction sliding using an interface friction angle of 22 degrees (friction coefficient of 0.4). The weight of the berm should be calculated using a unit weight of rubble of 110 pcf.

We recommend applying a factor of safety of 1.3 to calculate the allowable base friction sliding capacity of the berm.

Passive Earth Pressure of Rubble Berm

Full passive earth pressure requires a wedge to form in front of the wall. To fully mobilize ultimate passive earth pressure the passive wedge extends in front of the wall a distance several times the height of the soil berm. Therefore, for a berm of practical width, the passive earth pressure will be reduced compared to a typical basement wall. Likewise, when soil slopes downward, away from the wall the passive earth pressure will be less than for the case of horizontal ground surface. Finally, full mobilization of passive earth pressure requires the wall to move into the soil approximately 0.01 to 0.04 times the height of soil in front of the wall. Because this amount of movement is typically not desirable, an allowable passive earth pressure factor of safety is used for design.

Table 1 provides passive earth pressure coefficients (kp) for a range of potential berm geometries. The values in Table 1 are for a berm with a fill slope no steeper than 1.5H:1V.

An ultimate passive earth pressure equivalent fluid unit weight may be calculated by multiplying Kp by the assumed rubble material unit weight of 110 pcf. The recommended passive earth pressure distribution is triangular.

We recommend applying a minimum factor of safety of 2.0 to the ultimate passive earth pressure.

Table 1 – Passive Earth Pressure Coefficients

Berm Height (feet)	Bench Width (feet)[a]	Ultimate Kp
4	0	1.3
	4	5.7
8	0	1.3
	8	6.8
	12	8.0
12	0	1.3
	12	6.9
	18	7.9
18	0	1.3
	18	6.8

Notes:

a. The passive pressure coefficients assume the berm slopes down at no steeper than 1.5H:1V

Limitations

We have prepared this memorandum for the exclusive use of Lease Crutcher Lewis and their authorized agents for The Net project in Seattle, Washington. Our work was completed in general accordance with our Services Agreement dated December 11, 2020. Our memorandum is intended to provide our opinion of geotechnical parameters for design and construction of the proposed project based on our understanding of the intended construction and existing site and subsurface conditions. However, conditions can vary from our understanding and assumptions and our conclusions should not be construed as a warranty or guarantee of site conditions or future site performance.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this memorandum was prepared. No warranty, express or implied, should be understood.

Any electronic form, facsimile, or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by Hart Crowser and will serve as the official document of record.

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Scott Neuman

To: Veenstra, Matt
Subject: RE: 3rd and Columbia Demo - Active pressure on basement wall during rubble supported condition

From: Veenstra, Matt <Matt.Veenstra@hartcrowser.com>
Sent: Monday, February 22, 2021 3:53 PM
To: Scott Neuman <Scott.Neuman@kpff.com>
Subject: RE: 3rd and Columbia Demo - Active pressure on basement wall during rubble supported condition

Scott,
Some preliminary information to discuss.

The interface friction coefficient between the berm fill and either the concrete slab or native soil is not significantly different whether CDF is used or not; likewise for imported silty or clean soil. This is because I already assumed that the interface would be "dirty" from wet concrete dust, etc and that the native soil would get wet and potentially muddy during construction.

Therefore, it's reasonable to assume that lateral sliding along the interface at the bottom of the berm will control the total lateral resistance of the berm regardless of the strength of the material used to build the berm.
However, what will change is the unit weight of the material used to calculate the weight of the berm and resulting sliding friction force.
For CDF, we can specify a unit weight, I think typical is 110 pcf.
For CDF filling the voids in rubble, for 100% void space filled, the total volume could consist of about 50% concrete + 50% CDF; for an average unit weight of (110+140)/2 = 125 pcf. In reality, it will not be 100% void spaced filled with CDF… so, maybe you only get 115 to 120 pcf modified unit weight…
Since CDF is expensive and the gain in lateral resistance is relatively small where sliding will govern, it is probably more cost effective to just use imported soil backfill or even demolition debris from another site rather than CDF.
The exception is where CDF is used to fill a void space that is not otherwise accessible by backfilling (e.g. immediately beneath the floor diaphragm and the top of the berm backfill).

Regarding the effect of an intermediate slab within the berm. If we push to the left at the top of the wall with a max force of Ptop, can the wall transmit the force further down, or will it hinge at the location of the intermediate slab?

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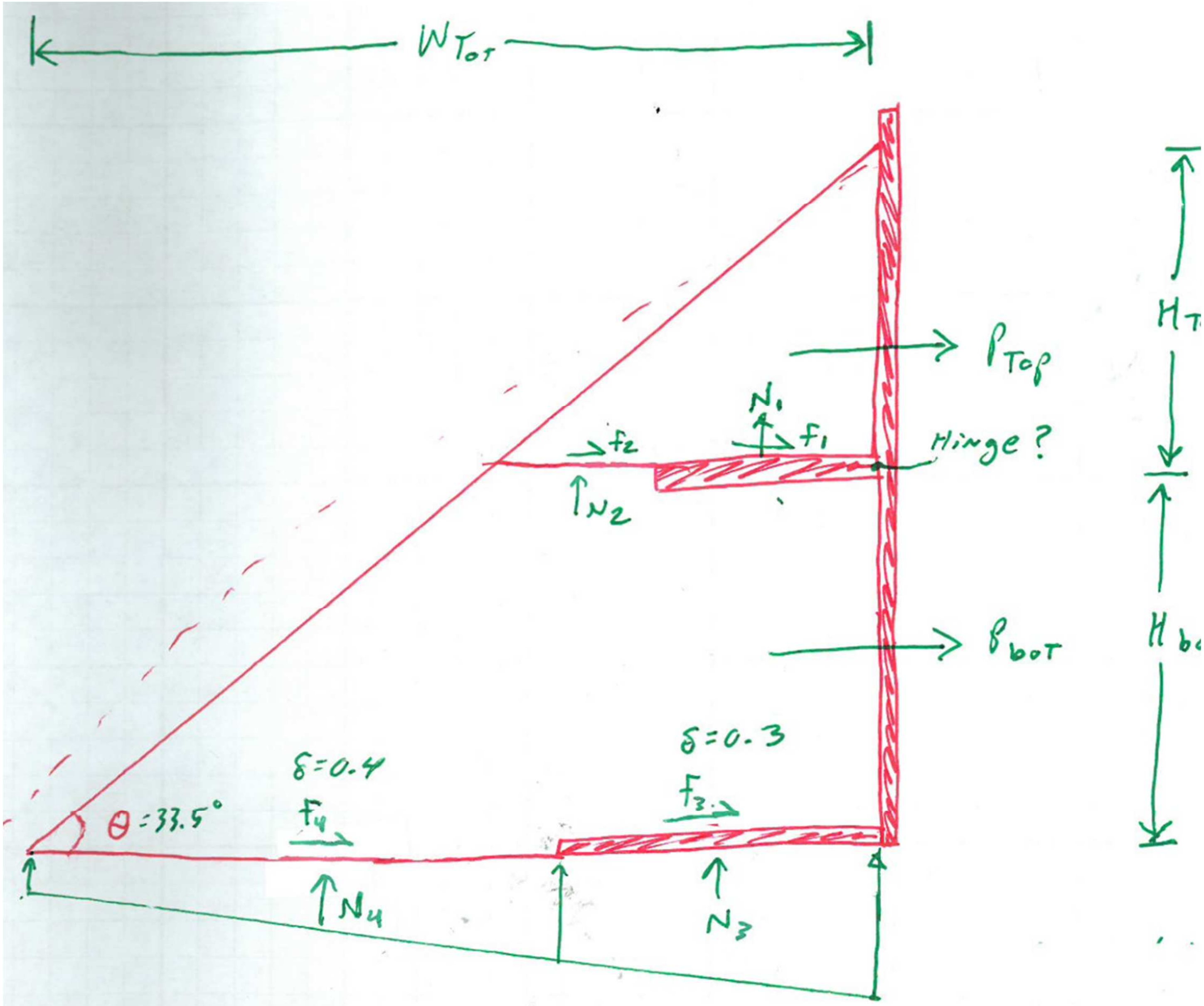

Matt Veenstra, P.E. | Associate
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Scott Neuman

To:	Veenstra, Matt
Cc:	Gavin Klein; Winter, David
Subject:	RE: 3rd and Columbia Demo - Active pressure on basement wall during rubble supported condition

From: Veenstra, Matt <Matt.Veenstra@hartcrowser.com>
Sent: Wednesday, May 5, 2021 8:51 AM
To: Scott Neuman <Scott.Neuman@kpff.com>
Cc: Gavin Klein <Gavin.Klein@lewisbuilds.com>; Winter, David <David.Winter@hartcrowser.com>
Subject: RE: 3rd and Columbia Demo - Active pressure on basement wall during rubble supported condition

Scott,
For CDF placed on the existing concrete floor slabs, we recommend using the same ultimate base sliding interface friction as for the rubble ballast material (friction factor = 0.3, or friction angle of 17 degrees).

Based on the Stoneway mix design data sheets provided by LCL, for the Flowable CDF, the design unit weight varied from 107 to 112 pcf. We recommend assuming the design unit weight of 107 pcf for the flowable CDF. For the stackable CDF, the design unit weight was 130 pcf for the two data sheets provided by LCL. We recommend a design unit weight of 130 pcf for the stackable CDF.

We understand that construction of the CDF berm will be by Contractor's means and methods. Note that the lateral pressure of the CDF during placement is equal to that of a fluid with a unit weight of the CDF which should be used to design the form work and the max lift height during placement of the CDF.

Based on slope stability / limit equilibrium analysis, base sliding still controls overall stability of the berm compared to passive resistance. This assumes a minimum unconfined compression strength of the CDF of 50 psi and assumes that the existing reinforced concrete basement wall is internally stable (cannot shear or bend excessively).

For the east wall berm with a height of about 18 ft, unit weight of 107 pcf, no bench, and 1.5H:1V backslope I get a factor of safety against overall stability (controlled by sliding) of about 1.4. Is this consistent with what you have calculated?

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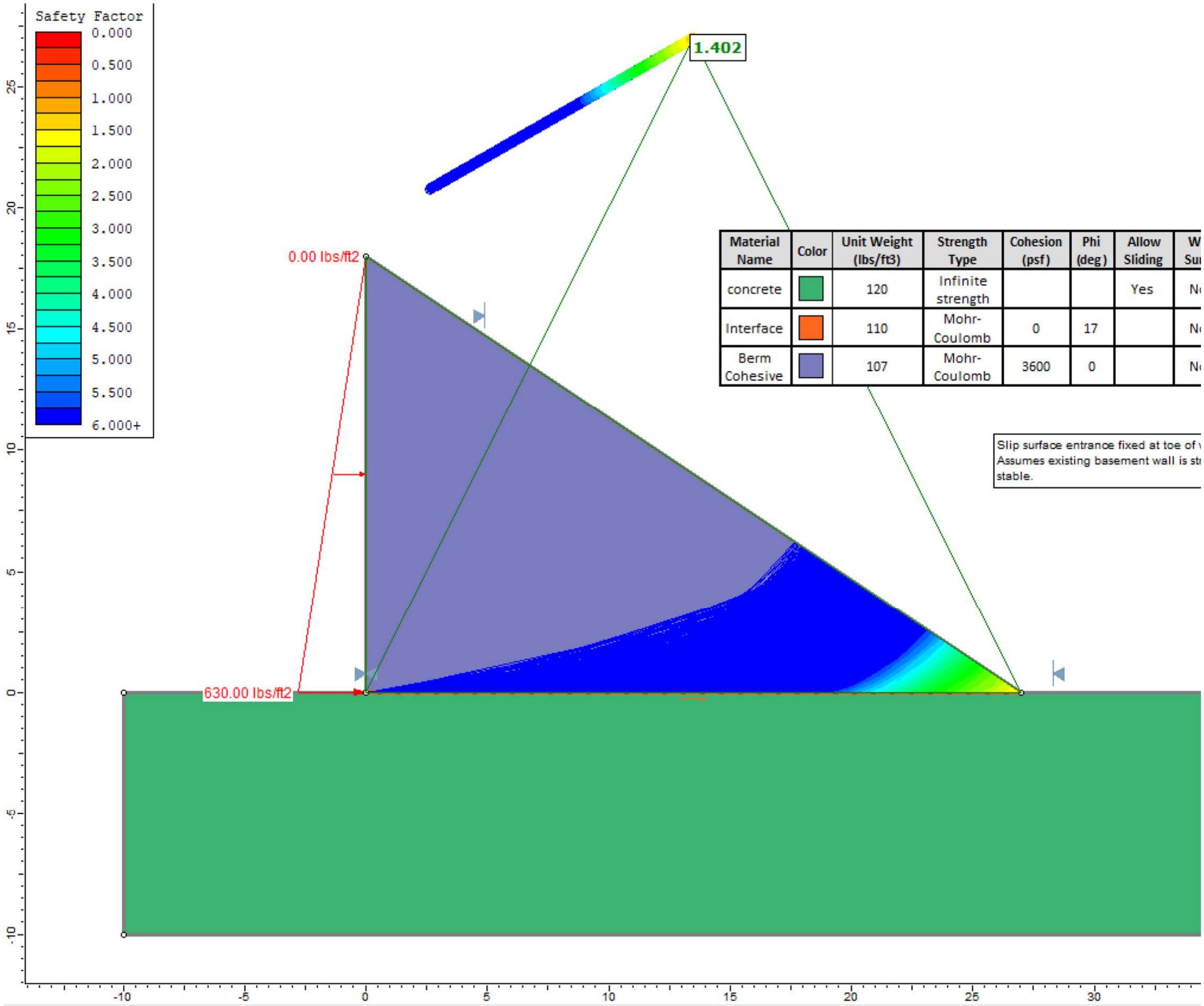

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Allow Sliding	W Su
concrete		120	Infinite strength			Yes	N
Interface		110	Mohr-Coulomb	0	17		N
Berm Cohesive		107	Mohr-Coulomb	3600	0		N

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Scott Neuman

To:	Veenstra, Matt; Gavin Klein
Cc:	Winter, David; Doug Maxfield; Mark Presleigh
Subject:	RE: 3rd and Columbia Demo - Active pressure on basement wall during rubble supported condition

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From: Veenstra, Matt <Matt.Veenstra@hartcrowser.com>
Sent: Wednesday, May 12, 2021 2:03 PM
To: Gavin Klein <Gavin.Klein@lewisbuilds.com>; Scott Neuman <Scott.Neuman@kpff.com>
Cc: Winter, David <David.Winter@hartcrowser.com>; Doug Maxfield <Doug.Maxfield@lewisbuilds.com>; Mark Presleigh <Mark.Presleigh@lewisbuilds.com>
Subject: RE: 3rd and Columbia Demo - Active pressure on basement wall during rubble supported condition

Gavin,
See below responses/comments in red.

1c. Not discussed in meeting: **Matt**, in your email with new recommendations for CDF you noted minimum compressive strength of CDF at 50 psi. From the Stoneway testing data they achieve 70 psi after (7) days, if we waited to demo the buildings until samples tested at >100 psi would that impact the size of the CDF berm?

[MV] No, sliding still controls.

2. Lewis to determine if roughening slab is practical and what can be achieved.
   a. Lewis can get ¼" variance in surface roughness with a scarifier or something similar.
   b. Other potential option: If the SOG was cored 5' on center (at some distance from the wall, maybe 15') and 6" steel tubes were imbedded into the SOG, would this have any significant reduction to quantity of CDF?

[MV] 2a – ¼" roughening would allow us to reduce uncertainty and increase the design coefficient of friction for base sliding to an ultimate value of 0.4 compared to the existing recommendation of 0.3. While, a value greater than 0.4 could be feasible, this would exceed the recommended coefficient of friction between the existing basement slab and the subgrade soils (0.4) which would then transfer the slip surface from the CDF berm-to-slab interface down to the slab-subgrade soil interface.

Note that KPFF should also check for sliding on the P1 slab and that slab may also require scarification for the sliding to calc out.

We still recommend a minimum berm slope of 1.5H:1V.

[MV] 2b – This option is not easy to quantify and is expected to be less accurate and reliable method of reducing CDF quantity compared to scarifying the existing slab.

3. A key attached to the existing slab on grade could be added to the end of the CDF berm.
3a. Matt/Scott: If a 2' tall key (material TBD) was added at the end of the berm what reduction in CDF quantity would you anticipate?

[MV] – A key would be beneficial; however, quantifying the benefit would be iterative process between HC and KPFF and would take additional analysis.

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Preliminarily, I expect that the berm would still need to be no steeper than a 1.5H:1V slope.

3b. Scott: Below I've pasted a screenshot of a section cut. During internal discussions we were having a hard time understanding what the critical failure we are currently designing for would look like. If we could determine how much the exterior wall would cantilever up from SOG, would this have the same effect as adding a toe at the end of the berm?

[MV] – I understand that Scott has already discussed this with Doug. This would not have the same effect as adding a toe at the end of the berm.

Additional thoughts:
I have seen flowable CDF produce a lot of water during placement and set up.
We want that water to be able to drain out and not get trapped underneath the CDF where it could reduce the friction and/or keep the CDF from coming up to strength on the underside of the berm.
A potential drainage option could be placing 1-ft wide strips of drain mat (e.g. Miradrain) every 20 feet on top of the existing slab to act as positive drainage; also consider sticking the drain mat down to the slab with adhesive and then place a few inches of gravel on top of it so it does not get easily displaced or float during CDF placement.

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May 21, 2021

Mark Presleigh
Lease Crutcher Lewis
2200 Western Avenue, Suite 500
Seattle, WA 98121

Re: **Plan Review and Minimum Risk Statement**
The Net - 801 3rd Avenue Demolition
Seattle, Washington
19567-01

Mark:

This letter provides Hart Crowser's geotechnical-related review of the structural submittal for temporary support of existing basement walls during demolition.

Plan Review

We have reviewed the following items:

1. "Lease Crutcher Lewis, 3rd and Columbia Demo, 801 3rd Ave. Building, Seattle, WA, Structural Calculations", dated 05/18/2021.

2. "Rubble and CDF Berm Design and Layout, 05/18/2021, KPFF"

In our opinion, the design and plans adequately conform to the recommendations provided in our geotechnical engineering design memorandum dated March 12, 2021, as well as supplementary recommendations communicated to KPFF by Hart Crowser via email and formalized in Hart Crowser Addendum #2 – Supplementary Recommendations, dated May 21, 2021.

Minimum Risk Statement

Regardless of the precautions taken and the level of engineering applied to the development, it is not possible to state that risks associated with the development do not exist. However, it is our opinion that the risk of damage to the proposed development or to the adjacent properties from soil stability will be minimal, provided that construction is carried out in accordance with the project plans, specifications, and our recommendations. By minimal, we mean that the risk is at a level generally considered acceptable in the local industry.

and our recommendations. By minimal, we mean that the risk is at a level generally considered acceptable in the local industry.

We trust this letter meets your project needs. If you have questions or if we can be of further assistance, please call.

Limitation

We have prepared this letter for the exclusive use of Lease Crutcher Lewis and their authorized agents for The Net project in Seattle, Washington. Our work was completed in general accordance with our Services Agreement dated December 11, 2020.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this letter was prepared. No warranty, express or implied, should be understood.

Sincerely,

HART CROWSER, A DIVISION OF HALEY & ALDRICH

MATTHEW WILLIAM VEENSTRA
STATE OF WASHINGTON
45280
REGISTERED
PROFESSIONAL ENGINEER

05/21/21

MATTHEW W. VEENSTRA, PE
Senior Associate, Geotechnical Engineer

DAVID G. WINTER, PE
General Manager

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HARTCROWSER
A division of Haley & Aldrich

May 21, 2021

Mark Presleigh
Lease Crutcher Lewis
2200 Western Avenue, Suite 500
Seattle, WA 98121

Re: Addendum #2 – Supplementary Recommendations
The NET - 801 3rd Avenue Demolition
Seattle, Washington
19567-01

Mark,

This letter provides formalization of supplementary geotechnical recommendations for CDF berms to be constructed for temporary support of basement walls at the 801 3rd Avenue building during and after demolition. This letter also provided a recommended monitoring program.

Supplementary Recommendations for CDF Berms

The following recommendations are an addendum to our previously submitted memorandum dated March 12, 2021, and are specific to berms built using flowable CDF. The recommendations in this addendum are supplementary to the referenced memorandum.

- For stability of the CDF berms, we recommend the following parameters:
- Unit weight of CDF of 107 pcf based on data reports for Stoneway Concrete Mix Code Number 1122, Flowable CDF, provided to Hart Crowser by Lease Crutcher Lewis on 04/28/2021. This mix has a specified minimum unconfined strength of 200 psi.
- Coefficient of passive earth pressure of 1.0.
- Base sliding coefficient of friction of 0.3 for CDF placed on existing basement and P1 slabs and 0.4 for CDF placed on slabs that have been scarified/roughened to ¼-inch amplitude.
- An interface friction angle of 17 degrees between the basement wall and the CDF.

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Monitoring Program

HCHA recommends the following monitoring program:

Optical Survey Locations

1. Interior walls – locate points near the top of the wall, spaced about every 15 feet.
2. Curb line – locate points on curb line across from basement area, spaced every 20 feet along the curb.

Optical Survey Monitoring Frequency

1. Interior Walls
    a. Baseline prior to removing adjacent wall diaphragm/existing support.
    b. Once per week during demolition.
    c. Once demolition is complete and bracing/shoring/rubble mounds are in place, and provided that survey data indicates little or no additional movement, reduce survey frequency to every other week.
2. Curb line
    a. Baseline prior to removing adjacent wall diaphragm/existing support.
    b. Start regular monitoring if interior wall data indicates movement of 0.5 inch or if there is a sudden change in wall movement.
3. Duration
    a. Optical survey should continue for a minimum of one month after demolition is complete and bracing/shoring/rubble mounds are in place.
    b. After one month, and provided that survey data indicates little or no additional movement, the geotechnical engineer, in cooperation with the shoring engineer, may recommend stopping the optical survey monitoring.

Reporting

1. Survey data to be provided to HCHA on a weekly basis for review.

Limitation

This letter is an addendum to our previously submitted memorandum dated March 12, 2021. The recommendations in this addendum are supplementary to the referenced memorandum.

We have prepared this letter for the exclusive use of Lease Crutcher Lewis and their authorized agents for The Net project in Seattle, Washington. Our work was completed in general accordance with our Services Agreement dated December 11, 2020.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this letter was prepared. No warranty, express or implied, should be understood.

Sincerely,

HART CROWSER, A DIVISION OF HALEY & ALDRICH

MATTHEW WILLIAM VEENSTRA
STATE OF WASHINGTON
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PROFESSIONAL ENGINEER

05/21/21

MATTHEW W. VEENSTRA, PE
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